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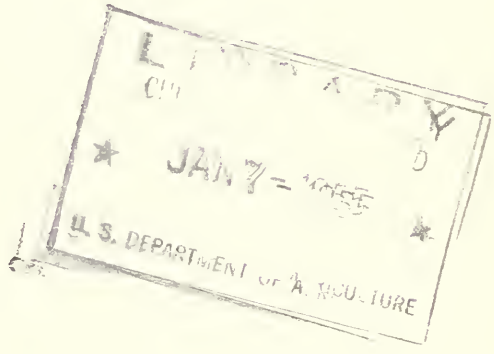
PROSPECTUS

YEARBOOK OF AGRICULTURE 1955

WATER



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YEARBOOK OF AGRICULTURE 1955

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NOTES FOR WRITERS

Nearly 300,000 copies of the Yearbook are printed. The book has an estimated million readers. No other publication has the same number and type of readers or offers such an opportunity to a scientist to announce his findings and discuss his work. The importance of the publication and our subject demands the fulfillment of several obligations and standards in writing, preparation of manuscript, attitude toward the assignment, promptness in submitting contributions and returning proofs, and fairness to all persons and colleagues. The contributor should bear in mind that the Yearbook is a cooperative venture of the Department of Agriculture, not of one bureau.

1. Our readers include farmers; city dwellers and others who have no prior interest in our subject but whose interest might be attracted; high school students; businessmen, economists, teachers, Government officials, and others, who need reference material; housewives; college students; county agents; Congressmen; writers. Among our many readers are only a few bureau chiefs, graduate students, and learned doctors; they appreciate clear writing and useful information as much as high school students do.

2. Authors should allow ample time before the time their manuscripts are due for the customary bureau clearance. The editor assumes that when a manuscript is submitted to him it is technically accurate and fully approved.

3. We do not specify the exact length of the articles. A rough average length would be 4,500 words, about 20 typed pages. But the writer should use all the words he needs to discuss his subject completely, clearly, and interestingly. No one needs to resort to terms like "Space does not permit me to..." or "In this brief paper, room is lacking...." Space, however, is always at a premium; do not overwrite.

Make every word count. Do not waste space on a long introduction. Long sentences are not bad in themselves, but they often indicate redundancy. Avoid summaries that merely repeat earlier material. Organize your material; outline your article first; know beforehand what you are going to say; then say it. Get a logical train of thought and follow it. Rework your manuscript several times, asking yourself each time: Is this clear? Is it terse? If your outline is good, there is seldom a need to backtrack (e.g., "as was pointed out in the foregoing paragraph"). Avoid verbosity in favor of the simple, direct English (e.g., "soon" for "in the near future"; "we learned" for "on the basis of a series of experiments it was demonstrated that..."; "in summer" instead of "during the warm summer months," and many more). Try to avoid, as space wasters, passive verbs. Good paragraphing, so that one discusses only one clearly identified point at a time, saves words. So do strong, active verbs (e.g., "one can assume" instead of "it would seem possible one could make the assumption that."

4. Some suggestions about choice of words:

Avoid dangling participles (e.g., "Applying pressure to such infected berries, the skin slips away..." should be "Applying pressure, one causes the skin...").

Avoid beginning sentences with this or these when the antecedent is indefinite and remote.

Do not overwork since when because or as can be used.

Due to requires a definite noun: "The failure was due to lack of study.

Avoid clauses like, "Many investigations showed that...." Giving the fact itself on your own responsibility is better.

Under Florida conditions and similar phrases are jargon.

Problems is overworked.

We use First World War and Second World War, not World War I and World War II, but we prefer using the years unless war bears on the point.

Use one word instead of a phrase whenever possible -- about for with regard to; if for in the event that or provided that; though for despite the fact that; before for prior to; after for subsequent to, etcetera.

Watch parallel constructions -- e.g., "The lesion was brown, sunken, and on the branches" should be "...brown, sunken, and persistent (or a third adjective)...."

That and which often involve meaning, not merely style.

Avoid using nouns as adjectives -- a common practice that makes for heavy writing.

Certain could better be some or a more precise term -- at certain intervals: every 3 or 4 days; certain workers: some workers.

Areas often is loosely used for districts, counties, localities, States, regions.

Define unusual terms the first time they are used by synonyms in parentheses or within commas or, even better, as a part of the next sentence.

Avoid abbreviations in the text.

Avoid prepositional phrases at the beginnings of sentences. "The study began in Florida in 1913..." instead of, "In 1913, a study was started...."

Avoid phrases like "last year," "recently," "a few years ago." Be specific as to year; remember this volume will appear in 1955, but will be in circulation much longer than that. Consequently a term like "this spring" is meaningless.

Avoid saying in the text, "Brown's findings were..." or "Smith and Jones disproved the theory...." Instead, gain accuracy and completeness by a phrase like "Lyle P. Brown, in experiments at the Alabama Agricultural Experiment Station, found that...."

5. The introduction and conclusion require extra thought. The introduction, the vital paragraph that determines whether the reader will continue reading your article or whether, so to speak, all your effort will be wasted, might well be a short statement of one challenging fact. A good device is a one-sentence paragraph so compact that it requires no internal punctuation. The introduction, besides attracting the reader, lays the groundwork for what follows. Usually questions do not make good introductions. A narrative flavor is good. Avoid like the plague long, historical introductions; they are dull, overworked, and usually not pertinent to the main point of the article. It's much better to jump immediately into the article.

We do not use "learned journal" summaries; they waste space. They are unnecessary if the article is properly written. Experienced writers save out a particularly good fact from the main body for use in the conclusion -- a fact that grows out of the text, looks forward, summarizes the main thought succinctly, and leaves a good feeling with the reader. Try for a pointed, crisp conclusion.

6. Material submitted for publication in the Yearbook must not be published or offered for publication elsewhere before it is printed in the Yearbook or is rejected by the editor. Please do not give your manuscript to another publisher or writer as background, or ask the editor if you may do so.

7. The Yearbook Committee plans the scope, content, and structure of the volume and advises the editor on problems of technical accuracy, suitability, and completeness. Problems of writing, presentation, duplication, illustration, and such are handled directly by author and editor after an article is submitted, not through a Committee Member or bureau official, although the editor usually keeps them informed of such details. There must always be the possibility of direct exchange between author and editor. Proofs particularly must be returned directly and expeditiously. All manuscripts are subject to revision by the editor. Usually they are returned to the authors before publication for comments, approval, additions (to keep them up-to-date), and corrections. Changes, however extensive, are always subject to the author's full, if not enthusiastic, approval. Changes are made primarily to remove duplication and repetition, eliminate wordiness and similar faults, enhance readability, and remove phrases, terms, examples, and such that are not objectionable in themselves but may be used in too many articles.

8. Contributors and other interested persons are invited to submit to Committee Members suggestions for papers not listed in this Prospectus, which is not offered as a final, static document. We want our book to be up-to-date, fresh, and living -- and different, not a rehash of old material.

9. Because the actual printing takes at least 6 months and the editing up to 6 months more, as much as a year elapses between the writing of an article and the appearance of the Yearbook. Authors, therefore, should follow through on their manuscripts and be sure that in each of its steps it remains accurate and up-to-date as of that particular date.

10. This Prospectus is not a secret or restricted document, but a great deal of effort is saved if each person to whom it is sent will remember that it is for his own use only and not for wide discussion or announcement.

11. Entries in this outline are topics, not necessarily the titles of the articles. Titles that authors use on their manuscripts should be short, accurate, and attractive. Changes may be made in them to conform to typographic style yet to be chosen or for reasons of succinctness and directness.

12. Subheads will follow the practice of the 1952, 1953, and 1954 Yearbooks. They are merely a line of space; the two or three key words that begin the next line are set in small capitals. The device saves up to 30 pages in the book and improves the appearance, particularly because of our narrow columns. Do not, therefore, use subheads as such in your manuscript. Subheads cannot be a substitute for good organization of thought and proper transition.

13. Avoid footnotes.

14. Publications may be mentioned in the text with the full name of the author and the work. We do not cite literature by numbers in parentheses in the text. For a general bibliography, authors may submit (on separate sheets) a list of major contributions bearing on his topic; these should give titles, authors, and other data accurately and without abbreviations.

15. Charts, line drawings, and black-and-white photographs of professional quality are welcome. We cannot use color photographs this year. Do not send negatives of photographs. Pack and label the pictures carefully. All precautions are taken, but the editor assumes no responsibility for the return of photographs or other art work. Submit no pictures that cannot become the property of the editor.

We try to get along without tables in the text. They are expensive to set, hard to fit into our narrow columns and generally unattractive. Often you can present the details in them more effectively as written matter; often they are submitted merely out of habit. Most readers skip tables. If tables are submitted, nevertheless, they must be on separate sheets by themselves, no matter how small. We cannot use what are

generally called "text tables." Tables, like charts and other "art" items, are set and handled separately. Do not use phrases like Fig. 3 or See chart 6 in the text. All items -- text, charts, tables -- should be self-contained, with a minimum of cross-reference.

16. Please submit with your manuscript a terse author's note that gives your name as you wish it to be printed, your position and affiliation, and a few highlights of your professional career. (See the notes in the 1952 and 1953 Yearbooks.)

17. Details of obtaining reprints are not handled by the editor of the Yearbook; consult your division of information regarding reprints or (if you are not in USDA) the Superintendent of Documents when the Yearbook is in print.

18. The following notes on writing are excerpts from a booklet The Publication of Research, issued by the Agricultural Research Administration in January 1945; the booklet reproduces a talk by the late Dr. E. W. Allen, who was Chief of the Office of Experiment Stations from 1915 to 1929:

The purpose of writing is not only to express ideas, but to communicate them to others. Science is not inherently dull, heavy, and hard to comprehend; it is essentially fascinating, understandable, and full of charm. It is simple, after it has been worked out, and is capable of being stated in concise terms easily understood.

But to succeed in conveying ideas correctly and in a readable way requires considerable effort on the part of most of us. It calls for time to do it well. It is just as important as making more experiments, although the worker may not like it as well, and it is quite as worthy of his best effort.

The aim in publishing research, as well as in carrying it on, is to leave the field clearer than you found it. If that cannot be done it is doubtful whether a scientific paper is justified. There cannot be clear writing without clear thinking, and when one learns to write clearly, he will in the process learn to think clearly. Indeed it may be doubted whether thought and its expression can be separated.

Clearness is absolutely essential in technical writing. It is not enough to use language that may be understood -- it is necessary to use language that cannot be misunderstood.

Having something to say, therefore, say it in your own way, provided you use good diction, the right word, and a simple form of expression.

Remember the reader. Be sympathetic toward him. He must make some effort, but he is not bound to follow you through. The writer has not the same hold on his audience that the speaker has.

Brevity is another important quality of a technical paper. This does not mean that the presentation should not be adequate to a clear understanding of what is reported and ability of the reader to judge the merits of the contribution; but the length should be proportionate to the actual contribution. Nowhere are more skill and judgment required.

The question of what to leave out will be one for very careful consideration, which frequently cannot be settled at the first writing. On review it may be found that considerable may be left out without sacrificing anything really essential. Descriptions and statements of facts gain force by brevity and by sticking quite closely to the real kernel of the subject.

As a rule, the more definitely a fact has been established by an investigation, the more directly and simply it can be presented. It is the doubtful ones that have to be hedged about with explanations, qualifications, and cautions.

The style of the technical paper should be simple, straightforward, and dignified. It should suggest neither a fairy tale, a sensational newspaper story, nor a sermon, but rather a simple, unaffected, and uncolored account of work done and its application. Accuracy and clearness ought never to be sacrificed to a supposedly more popular style. The presentation should be such as to win the reader's confidence in the thoroughness and reliability of the work reported.

NOTES ON TYPING MANUSCRIPTS

The Style Manual (1953 Revision) of the Government Printing Office governs capitalization, compounding, spelling, abbreviations, numerals, punctuation, syllabication, and plant names.

Submit to the editor the ribbon copy and the first carbon copy. The ribbon copy should be on good bond paper, not second sheets or onion skin, on which one can readily write with ink or pencil. The carbon copy, which also is used in editing (not merely for filing), must be perfectly legible. Use a fresh black ribbon. Change carbons often.

All material should be double-spaced; single spacing is not permitted anywhere -- not even in captions, at the bottoms of pages, or in the bibliography.

Do not run a paragraph over from one page to the next. Pages with run-over paragraphs cannot be sent to the printer. If a paragraph is too long for one page, split it arbitrarily if necessary. Very likely it's a poor paragraph anyway if it's that long. Do not use Scotch tape for any purpose on manuscripts.

Leave about 3 inches space at the top of the first page and 1½ inches at the sides. Other pages should have 1½-inch margins at the top and sides. Don't cramp pages, please; space is needed for marking type and instructions to the printer.

The number given the manuscript in this Prospectus should appear in the upper right-hand corner of the first page.

Underscoring means italics -- use it sparingly and advisedly, and not for emphasis.

Do not staple the pages of the manuscript together. Use paper clips.

Captions for photographs go on separate sheets -- one caption only on a page. Tables, author's note, and bibliography also go on separate sheets. Do not write with hard pencil on the backs of photographs.

Indicate subheads by skipping a few lines and underlining the first few words -- three lines under letters that are capitalized and two lines under the others (to indicate small capitals). The lines may be drawn in ink.

The sample pages of manuscript that follow show a model page 1 and a later page, on which a subhead occurs.

How Insecticides Are Developed

Jacques McGillicuddy

New insecticides are developed in two ways.

The first is by determining the structure of the active principles of plants recognized as toxic to insects. Then the principles or other compounds closely related to them are synthesized -- put together again to make the whole.

The second is by testing compounds of known structure and unknown toxicity upon several species of insects and selecting the ones that are effective.

The first method starts with a material of known toxicity but unknown structure. The second starts with a compound of known structure but unknown toxic value.

In 1943 the division of insecticide investigations of the Bureau of Entomology and Plant Quarantine received from Mexico City the roots of a plant reported to be used by Mexicans as an insecticide. The plant was incorrectly labeled Erigeron affinis, but Department botanists later identified it as Heliopsis longipes. The active principle was isolated and was identified as n-isobutyl-2,6,8-decatrienamide. Three other species of the genus Heliopsis were collected in several parts of the United States and tested for insecticidal value. Laboratory tests disclosed that all the species, particularly their roots, were toxic to house flies.

The first synthetic organic compounds used to kill insects were employed as fumigants. Carbon disulfide, made by the direct combination of carbon and sulfur, may be regarded as one of the simplest organic compounds. It was first used as an insecticide nearly 100 years ago in France. Paradichlorobenzene, originally a byproduct in the manufacture of chlorobenzene, was used as a substitute for naphthalene in combatting clothes moths in Germany in 1911.

PURPOSE

Our primary aim is to explain the nature, behavior, and conservation of water in agriculture. We address ourselves to farm people and to all those interested in rural living. As our population increases, more demands are being made on our water resources; the effective use and conservation of water on farms will become increasingly important, and conflicts over water use will have to be resolved. Some of the broad problems are forecast, but our main emphasis is on the facts and basic principles that will help people in reaching the best decisions. Hydro-electric power, navigation, industrial use, pollution, and other aspects are touched on, but this book is concerned almost entirely with water in agriculture.

CONSPECTUS

PART I: THE NATURE, IMPORTANCE, AND SOURCES OF WATER

L. The Nature of Water; Its Basic Chemical and Physical Properties.

A fact-packed chapter that explains what water is, lays the groundwork for later chapters, and interests and informs layman and scientist. Many homely details -- and the scientific details, too. The tetrahedral structure of the water molecule. Hydrogen bonding as the cause for the characteristic properties of water. The nature of snow, ice, and liquid water. The vapor phase. Viscosity. Surface tension and tensile strength. Change of state from solid to liquid to vapor and from vapor to liquid, and solid. Water as a reacting molecule (hydrolysis, rusting, et cetera). Water as a solvent (solutions of electrolytes). Mineral content. Energy relations. A basic definition of water as a compound and its primary reactions.

2. The Importance of Water to Human Beings.

The human body's need for water. How that need has influenced human and political history, society, transportation, and land settlement and our modern cultural, industrial, economic, and agricultural life. How water supplies have determined the location and character of cities, and the extent to which they now limit the growth of cities. The need for planning. A major purpose here is to interest all Americans in our vital subject and to make them want to read the rest of the book. A way to do that is to supply lots of illustrative detail and compelling facts, rather than generalities. It should be close to the experience of the average reader and have a sharp, unified focus.

3. The Importance of Water to Domestic Animals, Fowl, and Insects.

The varying needs of animals for water. Like human beings, most animals need plenty of fresh, pure water; the extent to which some can go without water for a while. How the needs bear on the development of ranches and other livestock-producing enterprises and the fencing of fields. In tables, charts, or other ways, the requirements of all domestic and common animals should be set forth. This chapter (with chapters 2, 4, 5, and 6 develops our presentation of the importance of water, but it also (like them) gives much useful, interesting information that farmers particularly can apply directly to their operations -- a sort of practical handbook. Water and insects; metabolic water. (May be separate chapter.) The needs of domestic fowl. (Note: Wild animals and wild fowl are treated in chapter 87; the needs of animals on range are discussed in chapter 81, but in a more specific way than here.

4. Water and Plants. (Leon Bernstein)

The overall need of water by plants. Structural characteristics: The cell, roots and root-hairs, the vascular system, stomata, zeromorphy. Transpiration: Function, mechanics, influence of environmental factors. The translocation of substances. Photosynthesis. Plants that need unusual amounts of water; those that need very little. How water supplies determine plant populations. How man can alter some of those relationships, but not all. (Note that specific requirements of rice, cotton, corn, grass, vegetables, and some other plants are given in chapters in Part II.)

5. Water and the Soil.

The role of water in the formation of soil in the natural landscape -- one factor among several operating within a complex where each factor influences the others. Leaching and natural erosion (which may be gradual or accelerated) are involved. The effects of water on soil in the landscape. Other effects include those of waterlogging, draining, alternate flooding (as in rice culture), and perhaps others. Another of the overall, introductory articles that bring out the importance of water, but it cannot be too general nor should it duplicate the more specific later chapters. One of its purposes is to make readers think of soil and water as closely related entities in farming, gardening, and conservation; without water (or with too much), land may be merely space.

6. Water and the Microbe.

The influence of atmospheric and ground water on the activity of harmful and beneficial micro-organisms. The pathogenic micro-organism: Influence of rainfall and humidity on the spread and control of airborne plant pathogenic micro-organisms; soil moisture and the soil pathogens. The beneficial soil micro-organisms: Effect of variation of soil moisture on the decomposition of crop residues; effect of soil moisture on the persistence and activity of nitrogen-fixing and nitrifying bacteria; soil moisture and the maintenance of soil organic matter.

7. The Water Cycle.

An overall, comprehensive treatment of the ways in which water occurs -- in the atmosphere, on the earth's surface as snow, in lakes, ponds, rivers, and oceans, and below the earth's surface. The movement of water above the earth's surface -- precipitation, evaporation (from water surfaces, snow, tree crowns) and transpiration, especially as related to the availability of water. The movement of water on the earth's surface. The movement of water below the earth's surface, such as percolation and capillary rise. Plenty of charts and drawings of the water cycle. Other factors, such as (perhaps) the climatic movement of the water-laden air, rain and snow, distribution into surface runoff and into lower strata, water into the ground-water reservoirs, evaporation, etc. Note the possibility of duplication with chapters 8, 10, 11, and 12, although the purpose of this chapter is quite different from their purposes.

8. Ground Water Resources.

How ground water is formed. Its relation to the hydrologic cycle and the weather. Its importance with reference to its use as a supplement to surface water and with respect to recent trends to greatly increased use and the overdrafts in some areas. The various types of ground water, such as shallow and deep; the relative ease of obtaining them and their qualities. The agencies that measure ground-water resources. A detailed map (or maps) of the United States or its regions will show the quantities of ground water available in the various places; they will be of great use to industry, agriculture, and city and regional planning bodies. (See C. L. McGuinness' Geological Survey Circular 114.) Problems of overdraft, dropping water tables, wells. (Cf. chapter 7.)

9. Methods Used to Locate Underground Water.

Divining rods -- their history, use, claims. How well drillers find water.

10. Surface Water.

The relation of surface water to the hydrologic cycle. Geographic distribution. The importance of surface water -- its abundance and relative availability. The system of surface water measurements by the United States Geological Survey and other agencies; the number of stations where measurements are made and methods of measurement. Three or more maps would show the places in the United States where surface water is measured, the annual amounts of surface water distributed over the United States, and the seasonal or monthly variations at selected locations. (If germane here, the subject of water quality -- chemical, biological, and sedimentation aspects -- may be introduced, but in a less detailed way than in the later chapters on those subjects.) (Cf. chapter 7.)

11. Distribution of Precipitation in the United States -- Climatic Regions.

The forms of precipitation, primarily rein and snow. The common storm types that produce precipitation. How precipitation is measured. The agencies, degree of coverage, and length of records in this country. A map that shows annual peecipitation by months. In the discussion of the latter, the areas of particularly high and low annual precipitation and unusual seasonal distribution and (perhaps) the relationships between rainfall excesses and floods, and rainfall deficiencies and irrigation should be pointed out. (Note that chapter 12 discusses dew, fog, high humidity, and cloudy weather as they bear on the needs for water; it might be combined with this chapter.)

12. Other Water Resources.

How dew, fog, high humidity, and cloudiness modify the climatic pattern, relate to plant growth, and extend or change the usability of other forms of precipitation. (See chapters 8 and 11.)

13. Weather Cycles.

The variations and cycles in weather. The changes by seasons in rainfall, temperature, and other factors. The short-term and long-term variations from normal -- the cycles, which may be as short as a few days, or as long as many years in length. The studies of many investigators who have related the cycles to sun spots, solar radiation, tree rings, and other aspects of periodicity. Little is known about the long-range cycles; the shorter variations and the normal seasonal cycles are reasonably well established, and can be improved with further measurements.

14. Seasonal Forecasts of Water Supplies as Aids to Water Users.

Adequate water at the proper time can mean the difference between a bumper crop or no crop in irrigated areas. Irrigators depending on snow melt run-off need reasonably accurate information on the quantity of

water they can expect during the growing season and the time at which it will be available. Crop selection and management can be varied to meet the anticipated supply of water if advance forecasts of supply are available. Measurement of the snow pack in the mountain areas provides an accurate basis for forecasting the total quantity expected. By applying long range weather forecasts, the rate at which the supply will become available can also be forecast. In addition to irrigation uses, forecasts are utilized for predicting flood flows and potential hydro-electric supplies.

15. Changing the Rains.

A review of the history of ideas leading to attempts at rain making through cloud seeding. Accomplishments, problems, potentialities. (Perhaps the use of explosives to break up potential hail storms.) The extent of use, particularly for farmers and orchardists.

16. Conversion of Sea Water.

A thorough-going discussion of the history, accomplishments, scope, and limitations of research on the conversion of sea water. The Congress in June appropriated $400,000 to the Department of the Interior for such research.

17. Reclamation and Reuse of Water That Has Been Used for Industrial and Municipal Purposes.

This is one of three chapters (15, 16, 17) that explore ways to add to our water resources or extend the ones we have. Is water ever "wasted"?

18. Pollution of Water.

The pollution situation in relation to usable water supply. (Cf. chapter 17.)

19. Trends in the Utilization of Water.

All phases of water utilization and disposal in line with current trends and thinking: Some of the problems in connection with irrigation -- lowering of ground-water levels, necessity of developing additional surface water supplies, and future needs for irrigation water. The relationships between irrigation, power development, flood control, and navigation requirements. In the Eastern States drainage activities, flood control, and power development have constituted major problems. Problems and trends and conflicting and competing uses of water. What is taking place in agricultural uses of water as compared with the past. Trends in industrial, municipal, and power usage of water. The amount of water used to make a ton of steel, a gallon of gasoline, et cetera. Some attention to the reuse of water in industrial processes and where possible in agriculture. The facts with reference to our total water supply should

be described. Do we have plenty of water if it were properly distributed and properly utilized, et cetera? A highly important chapter. It closes a section and lays the groundwork and thesis of the next major section -- the conservation of water. It can summarize somewhat the foregoing and look ahead to the main body of the book. (Cf. chapters 17, 97.)

PART II: THE CONSERVATION OF WATER

20. Soil Water and the Plant.

Soil-plant relationships as related to the soil moisture. The physical condition of water in the soil. Soil moisture stress in relation to plant growth, including the effect of salts. Significance of the wetting percentage. Entry of water into plants. Nutrient absorption and accumulation in relation to soil. Influence of soil moisture on physiological processes. Influence of soil moisture on the phases of plant growth. The extent to which plants obtain moisture from the atmosphere. Relationships of plant density, water, and fertilizer. Water tension. (Cf. chapter 4.) This is the first of six chapters that deal with physical and mechanical relationships of water and soil. They explain the bases of soil and water conservation and serve to introduce later chapters of this section, which is the main part of the book. The authors may find consultations with each other useful in avoiding overlapping and insuring a complete, coherent presentation.

21. Land-Water Relationships.

The part of the precipitation that falls on the land is greatly affected by the type of soil and vegetation it encounters. The general effects of land slope and the permeability and depth of soil layers in determining whether rainfall runs over the surface or soaks in. The role of vegetation as it influences the condition of soil and the path of runoff. With respect to soils and crops and forests man has upset the natural pattern of nature; this also is the principal place where man has an opportunity for modifying and improving the hydrologic balances. Most of the other factors in the hydrologic cycle, such as mass evaporation and precipitation, are still outside the bounds of man's influence, and can be described in a general way. Hydrologic methods for determining the contribution of surface runoff to streamflow.

22. The Intake of Water by Soil.

Most of the water needed by the plants and animals of the terrestrial parts of the earth is water of precipitation that has entered the soil mantle. Some of it may be immediately used by growing plants, some may feed springs or ground-water supplies, and some may seep to streams, lakes, and reservoirs. In much of the East, frequently half of the annual precipitation is measured in the streamflow, indicating that runoff is approximately of that magnitude. Along the western edge of the humid area (as in North Dakota and Kansas) only 10 to 20 percent of the annual precipitation reaches streams. But more precise information on the amount entering the soil comes from the many measurements made on

farm and woodlands; they show how the intake of water by soil is affected by man's use of the land. On the same piece of ground and with normal rainfall, the annual runoff may be as little as 1 inch or as high as 24 inches, the difference being due principally to the use and management of the land. Factors that affect intake of water. The smaller differences found on large watersheds.

23. The Mechanics of Soil Detachment and Movement by Water.

Primarily the mechanics of the processes through which unconsolidated material -- soil or unconsolidated rock -- is brought into suspension and then moved into streams. Wind erosion. Raindrops. (Black-and-white photographs of raindrops -- if new pictures are available.)

24. The Physical Principles of Water Flow.

The physical principles of water flow and movement as applied to the soil system. The relation of soil-water movement to crop production. Water penetration: Forces involved, wetting and swelling phenomena, physical and mechanical properties of soils. Water movement in soils: Saturated flow, unsaturated flow, diffusion and evaporation. Water movement and plant growth: Accessibility or availability of water, aeration, root penetration, salt movement, loss of water from roots.

25. Erosion, Transportation, and Deposition of Sediment.

Erosion, movement and deposition of sediment, and the damage resulting therefrom. The relative sources of sediment in a watershed, such as sheet and channel erosion, and the movement of sediment out of watersheds. Watershed and climatic factors that affect sediment yield from watersheds. The modes of sediment transport and the hydraulic and particle characteristics that affect sediment movement and deposition. The variations in sediment sources and in the sediment content of streams for various problem areas of the country. The damages resulting from deposition of sediment -- in stream channels, reservoirs, harbors, irrigation and drainage canals and on bottomlands. The effects of land treatment and channel stabilization measures in reducing sedimentation damages. Instances will be cited where such programs have been installed on watersheds and the resulting reduction in sedimentation measured.

26. The Watershed Concept of Resource Planning.

River basins, the natural subdivisions of our water resources, and watersheds, the natural units of river basins. The watershed, a unit for local, State, and Federal cooperation in planning. History of planning for watershed management. How a watershed project is developed; description of the planning steps; points included in a typical watershed plan. Illustrations of some outstanding corrective action and measures. (Cf. 27, 28, 30.)

27. The Landowners' and Operators' Part in Watershed Programs.

A watershed program is a responsibility also of farm owners and operators. The need for their initiative and cooperation in the initiation, installation, operation, and maintenance of programs, which should be joint ventures wherein farmers work with their neighbors and residents of cities and towns (and maybe governmental units and soil conservation districts) in solving watershed problems. Examples of river basin programs.

28. Urban Interests in Upstream Watersheds.

The general and specific interests of urban groups in the protection of upstream watersheds as a means of conserving land resources, preventing floods, controlling pollution, and insuring municipal water supplies. Examples of programs that have achieved those and other aims. (Cf. chapter 27, in which the examples illustrate programs that do not pertain to cities.)

29. The Yazoo Watershed Improvement Project.

History of the project, with emphasis on accomplishments and possible applications to other communities.

30. Other Case Histories of Watershed Operations, Improvement, Development, and Management.

Sandstone Creek (or another example): The actual performance as to land treatment and structural program since its installation. Brandywine and any others (at the author's discretion) that exemplify specific accomplishments beyond the planning stage. A narrative approach might be used. Details that will help other organizations or groups to achieve good results.

33. Floods in the United States.

Note: The following includes suggestions from various sources, which are here put together as though to form one chapter. The authors, however, could regard themselves as a committee to outline and prepare one comprehensive, well integrated chapter or several chapters about floods. They should guard against making the presentation a hodge-podge (as in these notes) or repeating commonly known details treated in one or another of the recent books on floods. The emphasis here should be primarily on prevention and on aspects farm workers will find useful.

The magnitude of flood damage to agricultural, urban, and industrial areas. The various types of damage (in dollar or other values) and indirect losses to crops and pasture land and other agricultural enterprises. Damages by geographic areas. The importance and frequency of damage in headwater streams and in major river valleys. Descriptions of a few disaster floods (e.g., the 1948 flood on the Columbia, the 1951 Kansas River flood, and the 1952 Missouri River flood) to show causes and prevention. How man's treatment of watershed lands can influence peak flow. The effect of bridges and dams on the stage of flood flows. Effect of

buildings on the floodplain. Early flood control work. The construction of levees and enlargement of channels. The shift of later emphasis from the concept of providing only enlarged channels and levees to the reduction of peak flows through the use of detention reservoirs. Recent interest in more comprehensive approach. Since approximately one-half of all flood damage occurs in the small, creek-size watersheds, more emphasis has been placed on the development of programs that include the treatment of watershed lands and which would provide a degree of control in upstream areas as well as on the principal rivers. Ground cover to retard runoff; terraces, contour farming, dams, and other mechanical means; downstream flood control. (Beware of duplication!) All floods are due primarily to surface runoff resulting from intense rainfall, melting snow, or a combination of both. Other factors -- such as the condition of the ground, ice jams, debris jams, et cetera -- often have a significant effect on the flood stage. Although not so common, the sediment content of flood flows has sometimes been found to be enough to make a material increase in the volume of flow. The encroachment of urban development on the stream channels and floodplains and the deposition of sediment and debris in the stream channels. (Cf. the chapters on watersheds.)

34. Floods from Western Mountain Lands.

Nature, extent and frequency of western mountain floods; climatic and physiographic characteristics of mountain lands that contribute to flood hazards; effects of wild fire, roads, and other disturbances to watershed cover or soil; appraisal of efforts to reduce flood losses at sources (and downstream) and in channels. Channel improvement and stabilization for protection against floods in the Los Angeles flood control district. Floods from mountain lands in Utah and Colorado. Fire-storm-flood relationships in the northern Rockies; case histories of consequences of forest and brush fires under given climatic and soil conditions. Note that the intent and scope here are different from those of chapter 33.

35. Possibilities and Limitations of Land Treatment in Flood Prevention.

The use of land treatment measures in terms of their effect on runoff, with particular emphasis on the conditions under which such treatment is limited in providing a reasonable degree of flood protection. The effectiveness of such measures under different sets of conditions, such as weather sequence prior to a rainstorm, intensity and duration of storms, character of the soil, size and frequency of storms, size of watershed, etc. Each of the four major regions of the United States might be treated in turn.

36. Role of Forests and Forest Soils in Receiving, Transmitting, Storing, and Releasing Water.

Forests and forest soils in humid regions receive large amounts of precipitation as snow or rain or both. Perennial streamflow and abundant ground water recharge characterize the hydrologic regime. Forests and their litter exercise both direct and indirect influences on water supplies by their effects on the physical structure of the soil -- thereby enhancing its ability to withstand the impact of heavy rains to infiltrate, store, and transmit water from rain or melting snow -- and by the manner in which they

help dispose of precipitation. In those processes the crowns of trees and understory plants, the litter and humus, the roots, and the associated organic activities play a measurably significant part. Under given conditions of climate, soil, slope, and exposure, the character and condition of the forest, and the uses to which it is subjected determine to a large extent the disposition of water from the time it reaches the crowns until it seeps out of the soil into streams, springs, or ground water reservoirs. Some influences, like interception by crowns and litter and transpiration, operate to reduce the amount of water that seeps out of the soil. Others operate to increase the rates and amounts of water that enter the soil surface and percolate downward -- in contrast to surface runoff. Those influences are affected to greater or lesser degree by the density of the forest growth, the kinds of trees and understory vegetation, the size of trees, the condition of the forest floor (resulting from fire, logging, grazing, et cetera), among other factors. (Cf. 38, 40, 41.)

37. What Water Means to the Forest.

Water is the medium by which nutrients dissolved in the soil are absorbed by the trees and transported from part to part; within the tree it becomes an essential medium for chemical processes of life and growth. Water makes up a large part of the tree's woody tissues and large quantities are given off to the atmosphere during growth. Influence on the forest of seasonal variations in the moisture supply -- the resulting direction and rate of succession in forest growth following disturbances of one kind or another, the intensity of competition between individuals for growing space, in the growth of individual trees, and ultimately in the character of the upper soil layers under the forest. The importance of changes in moisture conditions following cutting or other alterations in the forest cover to the forest manager; the effect of high moisture in the soil on the plans and timing of seeding, planting, thinning, and the type and intensity of harvest cuttings. The effect of low soil moisture. How water has affected the distribution of forest and woodland types in the United States and (perhaps) elsewhere; the variations in composition within the forest types as affected by water. Rain forests of the Pacific Northwest; their characteristics, and effects of management on their perpetuation; the silvicultural problems.

38. Frost and Soil Freezing as Factors in Flood Runoff and Erosion.

The extent to which water from winter rains or melting snow can enter the soil is affected by the condition of the soil pores in the surface and subsurface layers. In the northern and middle latitudes of the United States the occurrence of certain types of frost and soil freezing associated with depth of snow, soil moisture conditions, organic matter, and degree of soil compaction determines the rates at which water will enter the soil and in turn whether erosion, rapid flood rises or both will result. Knowledge of the type and extent of frost is therefore essential to determining the runoff characteristics of watersheds subject to spring or winter floods. Soil frost varies greatly in characteristics. Some types represent an impenetrable barrier to infiltration; some do not. Which type may occur -- where climatic conditions favor the occurrence of frost -- depends on the density and character of vegetation (e.g., spruce v. hardwoods), the depth

and character of the organic layer, and the compaction of the surface soil. Sometimes even slight disturbances of the forest or brush floor, as by surface fire, can cause changes in the type of frost leading to rapid surface runoff and soil displacement. The character or intensity of cutting and grazing practices also determine whether permeable (to water) or impermeable frost will occur during periods of freezing weather. (Cf. 36.)

39. Managing Forest Cover to Prevent Accelerated Erosion and Silt Pollution.

Types and duration of soil losses under various forest-soil conditions; problems of utilizing forest lands without impairing soil stability; types of uses that need close attention; basic principles in utilizing forests and woodlands to minimize soil instability; examples of constructive practices.

40. The Role of National Forests, Parks, and Other Public Forest Holdings in Watershed Protection.

Favorable conditions of water flows was one of the objectives stated in the 1897 Act which provided for administration of the forest reserves and in the Weeks Act of 1911, which provided for the acquisition of national forests in the Eastern States. In the management of the national forests, the aim is to give watershed protection priority over other uses. Approximately 1,800 towns and cities, hundreds of other communities, and thousands of residents of rural areas also receive all or part of their water supply from the national forests. Examples of watershed protection and management planning and operation on national forests and other Federal and State holdings.

41. Increasing Snow-Water Supplies From Forest Lands.

Importance of snow in forested mountain areas as source of water supply; influences of type and density of forest cover on availability for streamflow. Possibilities and limitations of increasing water yields by forestry practices. The planning and operation of water supply and flood control projects in the Rocky Mountain region; the physical factors affecting snow melt as a means of improving the accuracy of forecasts of both seasonal water yield and rates of runoff. Cooperative investigations by the Bureau of Reclamation and the Forest Service on a high forested mountain watershed in Colorado to determine the processes that influence changes in the characteristics of the snow pack from the time snow falls until it disappears as melt water or by other means. Measurements and analyses of rates of snow-melt, evaporation before and during snow-melt, and of the factors which affect those processes to get more accurate forecasts of runoff from melting snow. (Cf. 36.)

42. Southern Appalachian Mountain Forests as Sources of Water Supply for Population Centers, Farms, and Industries.

Amounts, quality, and distribution of waters from national forest and intermingled lands utilized for domestic and industrial and hydroelectric power purposes. Effects of land use and cover conditions on supplies; relations to private forest lands.

43. Soil Surveys on Mountain Forest and Range Lands.

Need for mountain soil surveys as a basis for area planning and land use. What the surveys involve; their value in determining hydrologic characteristics of watersheds or other units; applications to protective, developmental, and management activities in multiple-use programs.

44. Irrigation in Western Agriculture.

Importance of irrigation in crop production. Differences between humid- and arid-area irrigation. Irrigation, the last step in complete water conservation program on the farm, should be an integral, not a supplemental, part of farming operation. Present irrigation efficiencies in the West; the need and methods of improvement. The present activity and development; an evaluation of future trends for irrigation. Annotated summary of the trends in irrigation -- number of systems, size, acreages, by type of crop. Analysis of effect of weather on development trends; i.e., drought periods, periods of excessive precipitation, et cetera. Analysis of effects of product marketing levels upon development trends. The future of water development and irrigation potential. Bureau of Reclamation estimates of potentials.

45. Irrigation in Humid Areas.

The present activity and development together with an evaluation of future trends for supplemental irrigation in the humid areas. Annotated tabulated summary of the trends in supplemental irrigation: Number of systems, size, acreages, by crop type, by type of equipment. Analysis of effect of weather on development trends; i.e., drought periods, periods of excessive precipitation, et cetera. Analysis of effects of product marketing levels upon development trends. Future possibilities. (Cf. 44.)

46. Wells, Pumps, and Related Structures for Irrigated Lands.

The engineering aspects of wells, pumps, structures, ponds, et cetera, for irrigation water supplies. Outline of types of wells and the condition to which they are best suited: Dug wells, bored wells, driven wells, cable-tool wells, hydraulic rotary wells. Selection of casing and packing material; i.e., pre-perforated, screen-type, in-situ perforation, and gravel-envelopes. Techniques of well development and testing: Pumping cycles or surging; plunging techniques; air surging; test, preparation, and procedures. Factors in the selection of pumping equipment: Types of pumps -- areas of application; selection of power supplies; mountings and basic pipe and distribution structures. Associated structures for well installation: Overholding ponds and storage basins; development of well batteries.

47. Surface Irrigation Methods.

The importance of water distribution to maximum plant growth and water conservation. The problems of distribution, application, and methods of handling them. The relationships between surface, sprinkler and sub-irrigation methods. Soil type, water relations, erodability, slope, type of crops in relation to surface irrigation. Techniques and rules for

determining optimum lengths of runs, streams, and amounts of water to apply. Borders, furrows, corrugations, level irrigation, and controlled flooding, et cetera. Design criteria, advantages and disadvantages, relationships to soils, topography and climate, crops and labor requirements. Applying fertilizers in water and efficiencies. Equipment and structures.

48. Sprinkler Irrigation.

Sprinkler irrigation and soil type, water relations, labor, climate, erodability, slope, type of crops, and equipment. The basic components of various types of supplemental irrigation systems. Factors affecting the selection of equipment. Components of systems: Pumps and intake structures, power sources, pipes and fittings, sprinkler equipment. Factors in system design: Arrangements of mains and laterals; capacity of system components; size of laterals and mains; size of pumps and power units. Advantages and disadvantages of this method.

49. Subirrigation.

Subirrigation and soil type, water levels and drainage, slope, irrigation efficiencies, topography, subsidence, type of crops, their water requirement, root zone characteristics, and equipment and structures.

50. Salt and Alkali Problems Common to Irrigated Agriculture.

Saline and alkali soil conditions as they influence productivity and the role of water management in inducing and controlling those conditions: Characteristics and diagnosis of saline and alkali soils. Prevention and improvement of saline and alkali conditions: Leaching and drainage; water and soil management; salt-tolerant crops.

51. Seepage Losses from Canals and Laterals.

Problems related to small canals, laterals, and ditches; some consideration of large canals. Estimates of numbers and lengths of canals and laterals in the United States, quantities of water conveyed annually, losses of water by seepage, and damage to adjacent land from seepage losses. Methods of constructing canal beds in relation to preventing seepage losses and treatment of beds after construction for reducing seepage water losses. Canal lining in relation to type of bed material, canal shape, size, grade, and other factors. Materials used for canal lining including description, permanence, resistance to sprouts and root penetration, value in preventing seepage losses, and their practical application and cost estimates.

52. Preparing Land for Proper Use of Irrigation Water.

Need, costs, relations to soils, topography, and climate. Type of equipment, effect on irrigation efficiencies, relationship to borders, furrows, corrugations, et cetera. Need for adequate engineering assistance and maintenance of leveled land. Importance of overall coordinated plan to include leveling, ditches, structures, et cetera. Results that may be expected with good land preparation when coupled with proper operation or water management.

53. Water Requirements of Irrigated Crops.

Methods of determination, relation to climate, variation between crops, irrigation efficiencies. Importance in planning irrigation systems and projects. Seasonal use and peak use. Effect of methods of irrigation, effect of ground-water contribution, usable precipitation, and winter soil moisture carryover.

54. Estimating Irrigation Water Needs From Climatic Data.

The importance of water (example -- 77 billion gallons per day used in 17 Western States for irrigation matches all that used in all other 31 States for all purposes). Importance of knowing how much water is needed in older developed areas and in new developments (competition for water in old developments is growing; any new developments will require exact estimates of water need to balance justification). Latest methods of making quantitative estimates (Blaney-Criddle index, Lowry-Johnson index, Penman-Schofield index, Thornthwaite index -- see chapter 55). Examples of places where quantitative estimates have been made and results. Irrigation efficiencies as related to estimating irrigation needs of the farm and the irrigation project.

55. Predictions of Water Needs of Plants from Weather Data.

The results of Dr. Thornthwaite's work in this field.

56. Methods of Determining Soil Moisture Status.

The uses and importance of soil moisture data, and a material listing of the various methods used for determining soil moisture, including: The principles upon which the methods are based; the accuracy of the methods and what they measure; their practical application including costs and adaptability for use by research technicians and farmers.

57. Determining Whether or Not to Irrigate in Humid Areas.

How to find out whether or not to apply supplemental irrigation from the standpoint of: Predictions of water needs of plants from weather data and by other procedures; soils and topography; other factors, including type of farming, and availability of dependable water supply. (Cf. chapters 54, 55, 56.)

58. Determining When and How Much to Irrigate.

This article will present a discussion of the water-holding capacities of soils, depth of soil and rooting depths, relation to peak and seasonal use, and relation to maintaining optimum moisture levels.

59. Ground Water Pumping To Prevent Overdraft.

Techniques of ground water conservation. Shallow and pushed water tables; artesian water supplies; factors affecting specific yeild (permeability of water-bearing formation, area and nature of recharge zone,

nature of withdrawal). The hydraulics of wells, with an explanation of terms and conditions -- cone of depression, drawdown, radius of influence, static water table, et cetera; discussion of influence of well diameter, depth, nature of screens, and gravel envelopes. The theory of balanced pumping and of practices that assist in ground water conservation -- pumping tests to determine well capacity and flow characteristics; selection of pumping schedules; development of recharge areas or recharge wells. (Cf. chapter 60.)

60. Replenishing Underground Water Supplies.

Summary of history of recharge and present activities in the West. Importance of recharge program when evaluated against dwindling ground-water supplies. Maintenance of existing irrigated agricultural enterprise based on ground water. Evaluation of recharge as a storage facility when balanced against upstream reservoir storage. Present techniques and developments for increasing rates of entry of water into recharge areas.

61. Developing Water Supplies for Irrigation in Humid Areas.

The factors and problems involved in supplying adequate water. Selection and development of surface water supplies -- natural streams and ponds; storage reservoirs. Development of ground water supplies -- ground water hydrology as it affects water table conditions and artesian conditions; factors involved in development and management. Relation to State water laws.

62. Effective Drainage Systems for Agricultural Lands.

The selection and integration of various drainage practices for crop production on agricultural lands. Special drainage practices not included under surface drainage or tile drains. Outlet drainage systems-- investigation and surveys, organization to construct and maintain, operation and maintenance. Farm drainage systems -- investigations and surveys, planning and integration of surface drains, tile drains, and other drainage practices into effective systems, maintenance. Special drainage practices -- farm pumping plants, levees and dikes, mole drainage; other.

63. Drainage of Peat and Muck Soils.

The methods of drainage of peat and muck soils and the influencing factors. The rates of subsidence and importance of controlled drainage. Extent of drainage of organic soil. Surveys and investigations to determine the feasibility of drainage of peat and muck soils -- soil profiles, outlet conditions, land use, costs. Rates of subsidence. Drainage systems for organic soils -- dikes and levees, pumping requirements, drainage ditches, tile drains, mole drainage, water control structures.

64. Drainage in Agriculture.

The development and periods of activity in agricultural drainage; the potential drainage activity. History and development of drainage

enterprises -- changes in type of enterprise, State drainage laws, trends in provision for maintenance. Annotated tabulated summary of the trends in agricultural drainage: Number of acres, acreage by type (i.e., surface, subsurface or combination). Analysis of factors affecting the development trends, i.e., labor costs, costs of materials, periods of excessive precipitation. Analysis of the effects of product marketing levels upon development trends. (Cf. 62, 65.)

65. Drainage Problems and Principles.

The problems of excess water in relation to crop growth. How the excess water can be removed or controlled. Its effect on crop growth, soil temperatures, soil-air relations, plant-root development, and general soil physical conditions. Its relation to crop management; interference with planting and harvest operations, effect on access to fields, effect on crop selection. Principles of drainage; surface v. subsurface; factors affecting selection of surface drainage -- soil conditions, topography, crop and field management. Factors affecting selection of subsurface drainage -- principles of water movement through soils, effects of depth and spacing of lines and spacing of cracks, et cetera. (Note possibility of duplication.)

66. Tile Drainage.

Various tile systems and the factors affecting their selection, construction, and maintenance. Factors influencing selection and design of systems -- layout and plan; tile capacity, drainage coefficients, grades, et cetera; accessories -- surface inlets, sedimentation basins, control structures, relief wells, outlet structures, et cetera. Factors in selection of tile material and quality. Details of installation practices: Excavating, laying, blinding and back-filling; special instruction practices-- quicksand, peat, and muck; loads on conduits. Tile drainage maintenance.

67. Surface Drainage.

The principles and practices that are basic to the design of surface drainage systems. Breakdown and discussion of factors affecting selection of various types of surface drains. Random field ditches -- design, layout and construction. Surface drainage of flat land -- land smoothing, bedding, parallel field ditches, et cetera. Surface drainage of sloping lands -- cross slope ditch systems and diversion ditches. Factors in open ditch design: Drainage requirements -- rate and amount; channel design -- grade, cross section depth, side slope and velocity; auxiliary structures. Factors in selection of construction and maintenance equipment and methods. Classification and adaptation of equipment. Use of explosives. Maintenance -- preventative and corrective.

68. Pump Drainage.

The factors involved in agricultural drainage where levees, dikes, and pumps are essential to provide adequate removal of excess water. Factors in the selection of sites and areas where pump drainage is essential

and effective -- inflow control, internal collection ditch or tile systems, outletting problems, consideration of return-flow seepage. Outline of factors involved in the selection of pumps and power units: Design problems based on required capacities, lifts, et cetera; selection of power and power controls for efficient operation. Use of pumping installations for water table control -- drainage plus subirrigation.

69. Drainage and Disposal of Seepage and Waste.

Drainage of irrigated areas in the western United States. The extent of damage and impairment of irrigation systems because of high water table and rise of saline and alkali salts. The reclamation of damaged irrigated lands by drainage, leaching, and necessary investigations to determine the source and path of the damaging water. Adequate drainage systems of considerable depth are usually required. In some cases drainage through pumping from deep underground strata is the correct solution. The methods, possibilities of development, and extent of need of drainage systems for irrigated lands.

70. Drainage in Forest Management in the South.

The drainage of commercial forest lands as developing in Southeastern States. Drainage of large areas of timber lands, held in individual ownerships, usually by lumber, paper and pulp companies, can increase the rate of growth of trees. In many locations the drainage encourages the establishment of pine trees, which succeed slow-growing species such as cypress. The economic benefits, improved roads, better timber management, and fire control obtained with the drainage operations. Examples of the specific problems that have been worked out for large areas.

71. Drainage in the Red River Valley of the North.

The drainage problems and activities in the Red River of the North, which in 1925 was served by county and other drains organized under the provisions of State laws. The drought situation was especially severe in the 1930's, and there was no need for the drains. Many were filled in dust storms and by 1940, when normal rainfall occurred, there was a widespread drainage problem. Special appropriations were provided by the State legislature. Soil conservation districts were organized and provided technical assistance for county and farm drains. The counties cooperated by carrying out their responsibilities under county organizations. The type of work accomplished, extent, and the remaining work to be done and maintenance requirements. The improved drainage methods and procedures that have been introduced. The production aspects.

72. Conserving Water on Cultivated Lands.

Erosion problems of different major kinds of soil in cultivated fields. Decreases in yield due to erosion; possibilities of improving eroded areas; hazard of gully formation in different kinds of soils. Cropping systems and runoff control. Tillage and residue management for erosion control (including discussions of contour tillage). Terraces, strip cropping, crop rotations, and water disposal and retaining systems. Planning for erosion control on farms. Maintenance of surface soil structure. Mulches and organic matter on cultivated fields to conserve water.

73. Irrigation of Corn.

A summary of irrigation practices and water use for corn production. Estimates of irrigated acreages devoted to corn. Methods of irrigating corn. Effect of soil moisture levels (frequency and amount of water applied) on corn yields. Relationship between time of irrigation and physiological stage of growth, including the effect of soil moisture deficits on corn yields. Consumptive use, peak use rates, and profile extraction pattern of moisture by corn in relation to moisture use by other crops. Fertilization, plant population, and other management practices for the production of corn under irrigation.

74. Irrigation of Sugar Beets.

Irrigation practices and water use as they relate to production of sugar beets, including: Importance of sugar beets in western agriculture; consumptive use of water by sugar beets, including peak use rates and profile use; timing of irrigation in relation to physiological stage of growth; effect of moisture level on beet yields and sugar percentages; interrelationships between irrigation practices, fertility level and fertilizer practices, plant population, and other management practices and their effect on beet and sugar yields.

75. Irrigation of Cotton.

Acreage of cotton produced under irrigation. Methods of irrigating cotton. Consumptive use of water by cotton with a discussion of peak use rates and moisture extraction from varying soil depths as compared to other crops. Effect of soil moisture level (frequency and amount of water applied) on yields of lint cotton. Timing of irrigations with respect to stage of plant growth and its effect on yield and efficiency in water use. Effect of soil, fertilizer, and crop management practices on irrigation needs of cotton.

76. Flood Irrigation of Rice.

The peculiarities of rice irrigation from the standpoint of preparation of lands for irrigation; methods of flooding and control of water; times, lengths, and depth of submerging.

77. Irrigating Tobacco, Peanuts, and Soybeans.

Estimated acreages of tobacco, peanuts, and soybeans under irrigation. Methods of irrigating each crop. Consumptive use of water by each. Peak use rates and moisture extraction from varying soil depths as compared to other crops. Effect of soil moisture level (frequency and amount of water applied) on yield and quality. Timing of irrigations with respect to stage of plant growth and its effect on yield and efficiency in water use. Effect of soil, fertilizer, and crop management practices on irrigation needs of each of the crops.

78. Dryland Agriculture.

Dryland farming and the importance of moisture to crop production. Precipitation patterns (with maps) in dryland areas -- the quantity, seasonal distribution, intensity, and the influence of other climatic factors on the effectiveness of precipitation. What happens to rain, and estimates of amounts lost in runoff and by evaporation and used by crops and weeds. Methods of conserving moisture and utilizing it more efficiently. The effects of residue management practices, strip cropping, terracing, time and method of tillage, place of fallow, choice of crops and crop varieties, plant spacing, crop rotations and sequences, weed control, et cetera.

79. Irrigation Practices for Pastures and Hay Crops, Other Than Alfalfa.

Principles governing the irrigation of sod crops. Methods of irrigating hayfields and pastures. Timing of irrigations in relation to stage of growth, time of cutting of hay, and time of grazing pastures. Effect of moisture level (frequency and amount of water applied) on yield and qaality of hay and pasture, longevity of stands, species composition, etc. Consumptive use of water by major hay and pasture crops including a discussion of peak use rates and profile use. Discussion of tother management practices (soil fertilizer and crop) best suited to the production of hays and pastures and their relationship to irrigation practices and efficient water use. (Cf. 82.)

80. Irrigation Practices for the Production of Alfalfa.

Methods of irrigating alfalfa (border, corrugations, basin, subbing, sprinkler). Timing of irrigations in relation to stage of growth and time of cutting of alfalfa. Effect of moisture level (frequency and amount of water applied) on hay and seed yields of alfalfa. Consumptive use of water by alfalfa including peak use rates and profile use. Discussion of other management practices (soil, fertilizer, and crop) best suited to the production of alfalfa and their relationship to irrigation practices and efficient water use. Effect, if any, on incidence of disease. Special attention will be given the production of alfalfa in the drier regions. Some attention to other legumes.

81. Managing Rangeland and Western Pastures for the Maximum Conservation and Use of Water.

Extent and characteristics of runoff from different kinds of range and pastures on different soils. The effects of runoff and erosion by wind and water on production. Managing ranges and pastures for the best use of water: Establishing desirable forage species; proper stocking and grazing management; fertilizers. Mechanical practices: Contour furrowing; subsoil chiseling; water spreading. Evaporation-transpiration relations; effects of increasing, decreasing brush v. grass; problems in maintaining optimum soil moisture relations from standpoint of plant growth. Requirements of different types of livestock under different climatic and topographic conditions -- amount of water, spacing of watering places. A comprehensive chapter that can be of any length considered necessary and (at the discretion of the authors) can be split into two or more well integrated articles.

82. Management of Improved Pastures to Conserve Water.

83. Development and Management of Coastal Marsh Ranges.

There are more than two million acres of fresh-marsh and salt-marsh grazing lands in Louisiana alone -- with similar important areas in adjoining States. Until recently little was known about the forage plants of these marsh ranges, or how to increase their productiveness. Under improved management such ranges will support up to four cow-months of grazing per acre.

84. Water for Orchards and Vineyards.

Irrigation of tree, bush, and vine fruit. Estimates of irrigated acreages and water use of the major types of crops. Irrigation methods most commonly used for each group of crops. How irrigation practices for the horticultural crops differ from those commonly used on field crops. The frequency and amount of irrigation water to apply and the timing of irrigations in relation to the growth stage of the plant will be given. Other management practices that require special attention when water is applied to these crops.

85. Water for Vegetables.

Irrigation of vegetables (and flowers), with emphasis on the home garden; water management practices and techniques. Water requirements of vegetable crops relative to stage of growth. Consumptive use of water by important vegetable crops including peak use rates and profile use. Effect of moisture level on yield and quality responses.

86. The Most Effective Use of Water on Turfs and Lawns.

Methods of irrigation, frequency, and amounts. Instructions for installing a lawn sprinkler system. Other special water management techniques for the home-owner. Other management practices that are associated with good water management practices on turfs and lawns (parks, cemeteries, golf courses, estates, et cetera).

87. Water in the Management of Wildlife.

The distribution of most species of game is largely controlled by the water supply. Thus their range can be enlarged by developing water; often that can be done in connection with water development for livestock or other purposes. Animal response to water, types of developments, and benefits. Note. Chapter 3 considers domestic animals and domestic birds.

88. Watersheds and Fish.

In some States, notably Michigan and Wisconsin, special fisheries projects are concerned more with management of the watershed than with work on the stream because a stream reflects the condition of its drainage basin. The principles of the work and the accomplishments.

89. Making New Trout Streams.

The high granite country of the Sierra Nevadas has poor water-holding capacity. After the snow water has drained off, streams cease to flow. The construction of small storage dams at headwaters has created many miles of good trout waters, with benefit to fishermen.

90. Problems Connected With Water in Recreation Areas.

Pollution of water in recreation areas. Assuring safe drinking water. Keeping beaches safe.

91. Wetlands of the United States in Relation to Their Waterfowl Value.

The Fish and Wildlife Service in cooperation with the 48 States has conducted an inventory of marsh, swamp, overflow, and seasonally flooded lands not intensively used for agriculture to determine their abundance and distribution, ecological type, and waterfowl value. Those wetlands used by at least 90 percent of the waterfowl population are located on county and State maps, measured to determine acreages, classified into one or more of 20 recognized wetland types, and rated high, moderate, low, or negligible according to their usefulness to ducks and duck hunting in the State where they occur. This paper gives results of the inventory in terms of how waterfowl values should be treated in the advance land-use planning of public agencies engaged in operations such as drainage, filling, and flood control which reduce both the quantity and qaality of natural wetlands used by waterfowl. It also points out how the inventory can be used as a framework for planning waterfowl management programs in relation to habitat needs by flyways.

92. Wildlife Enhancement Opportunities in Watershed Protection Programs.

Watershed protection programs afford unique opportunities to demonstrate how the planned control of water in a sound land-management program can stabilize and improve conditions for fish and aame populations. This paper emphasizes particularly the importance of stream channel improvements and floodwater retardation dams which, if located and designed with a view to wildlife enhancement, can be a boon to local hunters and fishermen. State Game and fish departments, the Fish and Wildlife Service, and local sportsmen groups should get in on the ground-floor planning of these watershed projects to insure that every practicable opportunity is taken for increasing both the quantity and the quality of habitat for wildlife. Features of the watershed program that most affect wildlife habitat and suggests ways in which wildlife protection and improvement measures can be made part of the basic planning for each protected watershed.

93. Drainage in Relation to Waterfowl Production in the Black Prairie Region.

Drainage in the Black Prairie Region of western Minnesota and eastern North and South Dakota is removing annually about 22,000 temporary and permanent shallow-water areas totaling approximately 63,000 acres, most of which is first-class waterfowl production habitat. This drainage is slowly

and permanently reducing the amount of breeding habitat available to ducks in this, the best, duck breeding region in the Nation. Special studies of this problem by the Fish and Wildlife Service have been directed toward finding answers to these questions: (1) How essential are these water areas to duck production? (2) How much of this wetland is needed for waterfowl and where should it be located? (3) Can some types of drainage be modified to maintain or improve waterfowl values? (4) What is the most feasible means of assuring that wetlands are made available for waterfowl use? This paper gives the highlights of these investigations and the recommendations resulting therefrom. Primarily, it points to the need for more closely integrated agricultural and wildlife policies and programs.

94. More Wildlife from Wetlands.

The coastal marshes of Louisiana and Texas are our most important wintering grounds for migratory waterfowl. These marshes along with large and small inland marshes produce vast numbers of muskrats and other furbearers. The productivity of these wetlands can be increased by manipulation of water levels and vegetation.

95. Farm Ponds.

Fish in farm ponds and streams; ponds to attract waterfowl and upland game. Perhaps: Construction of farm ponds; their uses and management.

96. Control of Water Losses by Riparian Vegetation in the Western States.

Extent and nature of the problem; relation to sedimentation; efforts to control; possible remedies; advantages and disadvantages.

97. Water for Industry.

Types and amounts; development and cost of water; water auality and treatment. Purification for industrial uses. Other details about water and industry. Localities of ample and scant supplies. An important chapter, and the only one we have on this subject. It should be comprehensive. (Note, however, references in chapters 17, 19.)

98. Water Supplies and Sewage Disposal for Rural Homes.

This chapter has two major divisions -- supplies and sanitation, and it may be split into two or more articles. A comprehensive, practical, well illustrated piece that considers quality: Pollution of rural sources of water; chemical and bacteriological pollution and treatment. Public health regulations. Farm water systems: Wells, pumps, et cetera; piping systems, and fixture installations. Water for fire protection on the farm. Disposal of waste water: Septic tanks, other systems for disposing of sewage and waste. How to purify water by boiling or chemicals. Tests to insure pure water. How to soften hard water. Springs. Surface water for farm use. Hot water for the farm home. A separate chapter might consider rural water companies or organizations -- types, supervision, financing, charges, et cetera.

PART III. LAWS. ECONOMICS. PROGRAMS.

99. Local Organization for Water Utilization and Control.

The special place and need for an effective organization of farm operators and water users on a local or watershed basis. Types of local organizations now carrying out specific functions in the use of our water resources. Analysis of the functions now performed by existing organizations in relation to what might best be done through local effort. Present legal restrictions on local organizations with some summary information by States of enabling legislation for different types of local organization. Suggestions on how local interests might best carry out their responsibilities in programs to develop watersheds and other water resources. Examples of how action by local groups solved specific and different problems. (Cf. chapter 26.)

100. Sharing Financial Responsibility for Developing Water Resources.

Factors to be considered in the allocation of financial responsibility, including the significance of the project to total national welfare as related to its contribution to purely local interests and the cost of the project in the relation of the ability of local beneficiaries to meet such costs. Actual record of specific cost-sharing arrangements and the basis for their establishment. Review of the problems of assessment of cost to beneficiaries, especially to secondary beneficiaries. The need for Federal taxing authority to handle major water resource projects. The sources of money are not necessarily proper criteria for determining project administration -- operation and maintenance.

101. Evaluation of Water Resource Programs.

Why evaluation is required -- as a basis for selecting most desirable projects; as a basis for determining the proper scale of each function to be provided by the project; and to meet basic legislation and policy requirements. How evaluation is made -- kinds of basic data needed, kind and nature of assumptions required and some resume of procedural techniques. Alternative bases for appraising projects -- qualitative analysis; financial or repayment feasibility; monetary evaluation of costs and benefits; and combinations. Special problems and considerations -- the weight to be given to secondary effects; the importance of intangible effects; and the problem of price and cost projections. Possibilities and limitations of economic evaluations. Overall requirements for an effective method of guiding public investments in resource development. Adjustment of competitive grazing, forest, recreation interests. Method of development. Big and small structures; structures and watershed management practices. Descriptions of famous projects. The measurement of the worth of water and water control; future trends (short and long range, public and private); capital and credit problems relating to water development (public, private).

102. Water Law.

State Water Codes -- surface and ground. Controls on use of water -- State water pacts, beneficial use concept, special and emergency control measures. The individual's right to the use of water -- what are water rights, how to get a water right, loss of water rights, priority in water use.

103. What the Department of Agriculture Is Doing in the Water Management Field.

Activities in water management either on an individual agency basis or on the basis of activities without regard to the agencies involved -- the Department of Agriculture, the Geological Survey, the Corps of Engineers, other Federal agencies, State agencies. The purpose here is to give a helpful summary of the government activities that pertain to the use and development of water resources. It must be more than a mere catalog of agencies and their functions. (If it is that, it should be a listing only, and should be in the appendix.) It will direct the taxpayer, the official, and the student to places where they can get more information regarding their problems and interests. It will be a completely objective, matter-of-fact summary of functions, responsibilities, and enabling acts.

104. Current Research on Problems of Sources, Use, and Development of Water.

105. Needed Research on Water.

For this chapter, each contributor is invited to submit (with their manuscripts or directly to Dr. Salter or Dr. Kelley) items on which more research is needed in respect to their own fields.

106. Educational Materials on Water Conservation for Schools and Civic and Conservation Groups.

107. River Basins Planning as Bases for Planning for Water Resources.

108. Water Policies in the United States.

109. Appendix.

The following are some of the Department bulletins and other available publications that deal with various aspects of our subject. Contributors may want to check them to see what has already been published in our field. The list is not a bibliography.

John T. Bowen: Harvesting and Storing Ice on the Farm, U.S.D.A. Farmers' Bulletin 1078. 1920, revised 1933.

Verne E. Davison: Farm Fishponds for Food and Good Land Use, U.S.D.A. Farmers' Bulletin 1983. 1947.

George M. Warren: Simple Plumbing Repairs in the Home, U.S.D.A. Farmers' Bulletin 1460. 1925, slightly revised 1948.

Harry L. Garver: Safe Water for the Farm, U.S.D.A. Farmers' Bulletin 1978. 1946, slightly revised 1948.

C. W. Gee: Taming Runaway Waters, U.S.D.A. Agriculture Information Bulletin 16. 1949

C. L. Hamilton and Hans G. Jepson: Stock-Water Developments: Wells, Springs, and Ponds, U.S.D.A. Farmers' Bulletin 1859. 1940.

C. L. Hamilton: Terrace Outlets and Farm Drainageways, U.S.D.A. Farmers' Bulletin 1814. 1939, slightly revised 1946.

Tom Dale: When Drought Returns to the Great Plains, U.S.D.A. Farmers' Bulletin 1982. 1947.

F. L. Duley and J. C. Russel: Stubble-Mulch Farming to Hold Soil and Water, U.S.D.A. Farmers' Bulletin 1997. 1948.

Tom Dale: For Insurance Against Drought--Soil and Water Conservation, U.S.D.A. Farmers' Bulletin 2002. 1950.

United States Forest Service: Know Your Watersheds, U.S.D.A. Leaflet 282. 1948.

W. L. McAtee and S. E. Piper: Excluding Birds From Reservoirs and Fishponds, U.S.D.A. Leaflet 120. 1936, slightly revised 1937.

Harry H. Gardner and Edwin Freyburger: Grass Waterways, U.S.D.A. Leaflet 257. 1949.

Bernard Frank and Clifford A. Betts: Water and Our Forests, U.S.D.A. Agriculture Information Bulletin 71. 1946, slightly revised 1951.

Edwin J. Core: Border Irrigation, U.S.D.A. Leaflet 297. 1951.

J. W. Rockey and J. W. Simons: Sewage and Garbage Disposal on the Farm, U.S.D.A. Farmers' Bulletin 1950. 1944, revised 1946.

Walter S. Atkinson: How To Build a Farm Pond, U.S.D.A. Leaflet 259. 1949.

J. G. Hamilton, Grover F. Brown, Harold E. Tower, and Wilkie Collins, Jr.: Irrigated Pastures for Forage Production and Soil Conservation, U.S.D.A. Farmers' Bulletin 1973. 1945.

Allan W. McCulloch and Wayne D. Criddle: Conservation Irrigation, U.S.D.A. Agriculture Information Bulletin 8. 1950.

H. N. Holtan: Holding Water in Farm Ponds, U. S. Soil Conservation Service SCS-TP-93 (processed). 1950.

United States Rural Electrification Administration: Planning the Electric Water System and Plumbing for Your Farmstead, U.S.D.A. Miscellaneous Publication 674. /1949/

United States Department of Agriculture: Water in the West; Report of the Western Water Committee of the U. S. Department of Agriculture (processed). 1941.

United States Soil Conservation Service: A Manual on Conservation of Soil and Water, U.S.D.A. Agriculture Handbook 61. 1954.